

REMARKS

Claim Rejections Under 35 USC § 102

Claims 1 and 22 are rejected under 35 USC § 102(b) as being anticipated by U.S. Patent No. 4,827,138, to Randall.

Applicants' amended Claims 1 and 22 clearly distinguish applicants' invention from the Randall et al. reference, and applicants respectfully contend that these amended claims are not anticipated by the Randall reference.

Randall discloses a mask which is useful in parallel-printing ion beam lithography. The mask represents a relatively rigid screen constructed from a relatively rigid material, such as monocrystalline silicon, with meshes formed through the screen over the entire area of the screen. The preferred embodiment applies a less rigid filler material into the meshes over the entire area of the screen, then removes the filler material from transmissive areas of the mask. (Abstract)

As indicated above, Randall teaches the use of a filler material within open areas of a mesh for purposes of preventing transmission through the areas of the mask in which filler is applied. The completely-formed mesh is present before the filler is applied. For example, at Col. 4, lines 1 - 68, Randall teaches forming a structure starting with a substrate 10, which is typically monocrystalline silicon. An epitaxial layer 12 containing a high concentration of boron is grown on the surface of substrate 10. A protecting layer 14, such as an oxide, metal, or nitride layer, is deposited over epitaxial layer 12. A resist layer 16 is then applied over protecting layer 14. Continuing at Col. 5, lines 1 - 60, the resist layer 16 is next exposed to radiation and developed to form a grid-like pattern (the mesh pattern). The patterned resist layer 16 is then used as a mask for pattern etching of protective layer 14 and epitaxial layer 12. At Col. 5, lines 61 - 65, Randall states: "After etching through layer 12, an etch-back step is used to entirely etch away substrate 10 from epitaxial layer 12 underneath the portion of epitaxial layer 12 which serves as a mask after subsequent processing steps. . ." At Col. 6, lines 3 - 6, Randall further states: "FIG. 4 shows a side view of the structure

which results after this etch-back step. This resulting structure forms a screen 22 comprised of the material from epitaxial layer 12 and protection layer 14." It is subsequent to formation of the entire grid-like pattern that fill material is added to portions of the grid.

Applicant's claimed invention is a method for forming a mask assembly for use in e-beam lithography. Due to the time difference between the Randall reference and applicants' invention, the size of features being formed in semiconductor lithography had decreased substantially and the size (surface area) of the mask had increased substantially. As a result, construction of a uniform grid pattern exhibiting dimensional stability had become a problem. Applicants were unable to form a grid pattern by a single etch step in which material was removed from a substrate without creating dimensional stability problems during formation of the grid. This is described in applicants' Specification as originally filed at Page 2, lines 12 - 25. Applicants had to create a portion of the desired grid where the walls supporting the windows were wider (thicker) than desired, fill the windows with a fill material, and then create additional portions of the desired grid, where the fill material supported walls adjacent the newly created portions of grid. This technique is described in applicants' Specification at Page 3, lines 5 - 14, for example. Randall does not teach or even suggest this sequential method of forming windows in a substrate; Randall teaches forming windows in a single etch step.

As described in detail above, Randall does not teach or even suggest applicant's invention, as claimed in amended independent Claims 1 and 22. In light of the above distinctions, applicant respectfully requests withdrawal of the rejection of Claims 1 and 22 under 35 USC § 102(b), over Randall.

Claim Rejections Under 35 USC § 103

Claims 2 - 5 and 20 are rejected under 35 USC § 103(a) as being unpatentable over Randall, in view of U.S. Patent No. 6,168,890, to Takahashi.

The deficiencies of the disclosure of Randall with respect to the patentability of the presently claimed invention are discussed in detail above, with respect to the rejection of Claims 1 and 22 under 35 USC § 102(b).

Takahashi discloses substrates for forming a microlithographic mask having a first membrane, as well as masks formed from such substrates. The emphasis is on the membrane of the mask which preferably includes a thin crystalline layer (e.g., silicon) containing an impurity (dopant). Each atom of the impurity has an atomic radius that is smaller than the atomic radius of atoms of the crystalline material. (Abstract) The dopant is used to introduce tensile forces into the membrane portion of the mask, to compensate for compressive forces which are introduced during the formation of an oxide layer adjacent the membrane. There is a discussion of the formation of struts which support the membrane portion of the mask, which struts form a rigid network beneath the membrane. However, the strut formation is via a single etch process in which a layer of silicon beneath the membrane is etched to form the struts. The strut formation is described at Col. 7, lines 34 - 61.

Takahashi is cited by the Examiner as teaching various masks for electron beam or charged beam lithography. The Examiner states that it would have been obvious to one of ordinary skill in the art to use the conventional charged beam masks described in Takahashi in the electron beam method of Randal. However, applicants' invention pertains to a novel method of forming a mask assembly which provides a dimensionally stable support structure (windows grid). Neither of these cited references describe or even suggest applicants' novel method with an emphasis on formation of a stable support structure; and, since both references teach formation of the support structure in a similar single step etch process which is different from the two alternative methods for grid

formation which are proposed by applicants, a combination of the teachings of these two references will not lead one skilled in the art to applicants' claimed invention.

Whether taken alone or in combination, neither Randall nor Takahashi teaches or even suggests applicant's claimed invention. In light of the above distinctions, applicant respectfully requests withdrawal of the rejection of Claims 2 - 5 and 20 under 35 USC § 103(a), over Randall, in view of Takahashi.

Claim 13 is rejected under 35 USC § 103(a) as being unpatentable over Randall, in view of Takahashi, as applied to Claim 4, and further in view of U.S. Patent No. 5,899,728, to Mangat et al.

The deficiencies of the disclosures of Randall and Takahashi with respect to the patentability of the presently claimed invention are discussed in detail above.

Claim 13 has been amended to place it in the format of an independent claim, for purposes of clarification. Claim 13 now recites the formation of a first assembly which is a filled-windowed substrate, the formation of a second assembly which is a second substrate having deposited thereover a mask layer followed by a membrane layer, and then bonding the filled-windowed layer to the membrane layer, after which the substrate overlying the mask layer is removed to expose the mask layer. This is an alternative method of producing the kind of structure produced by the method of Claim 4 (prior to removal of the temporary fill material).

Mangat et al. discloses a method of forming a lithographic mask that comprises the preparation of two assemblies similar to those described by applicants and recited in Claim 13 and then bonding these assemblies together to form a mask. However, the base / support structure of Mangat et al. is produced by etching all of the base pattern simultaneously. This is described at Col. 4, lines 53 - 67, continuing at Col. 5, lines 1 - 7. There is no description of the problem recognized by applicants with respect to maintaining the mechanical stability of the base / support structure during its formation. There is no teaching or even suggestion of the use of a temporary fill material

to support portions of a base/support structure during the formation of other portions of the base/support structure so that particularly thin walled windowed support structures can be created.

The Examiner states that it would have been obvious to one of ordinary skill in the art to use the patterning and bonding method of Mangat in the method of Randall in view of Takahashi. However, even if this is true, none of these three references even suggests applicants' novel method of producing a windowed support structure. Even if one were to combine the teachings of Randall with those of Takahashi and Mangat et al., one skilled in the art would still not arrive at applicant's invention as claimed in Claim 13.

Whether taken alone or in combination, neither Randall, nor Takahashi, nor Mangat et al. teaches or even suggests applicant's claimed invention. In light of the above distinctions, applicant respectfully requests withdrawal of the rejection of Claim 13 under 35 USC § 103(a), over Randall, in view of Takahashi, and further in view of Mangat et al.

Claims 6, 7, 11, 12, 14, 25, 19, and 21 are objected to as being dependent upon a rejected base claim, but are indicated to be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Applicants respectfully contend that in view of the amendment of their independent claims; and in view of the amendment of dependent claims to form independent claims (for purposes of clarification), the presently pending claims are allowable, including claims which were previously objected to.

Claims 8 - 10, 16 - 18, and 23 are allowed.

Applicants respectfully contend that the presently pending claims as amended are in condition for allowance, and the Examiner is respectfully requested to enter the present amendment and to pass the application to allowance.

The Examiner is invited to contact applicant's attorney with any questions or suggestions, at the telephone number provided below.

Respectfully submitted,



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